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Title: Imaging Spent Fuel in Dry Storage Casks with Cosmic Ray Muons

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IMAGING SPENT FUEL IN DRY STORAGE CASKS WITH COSMIC RAY MUONS

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Benefit

Highly-penetrating cosmic ray muons can image SNM through significant amounts of shielding that defeat other radiographic probes. This is the only feasible method of verifying the spent fuel content of sealed dry storage casks.

Applications

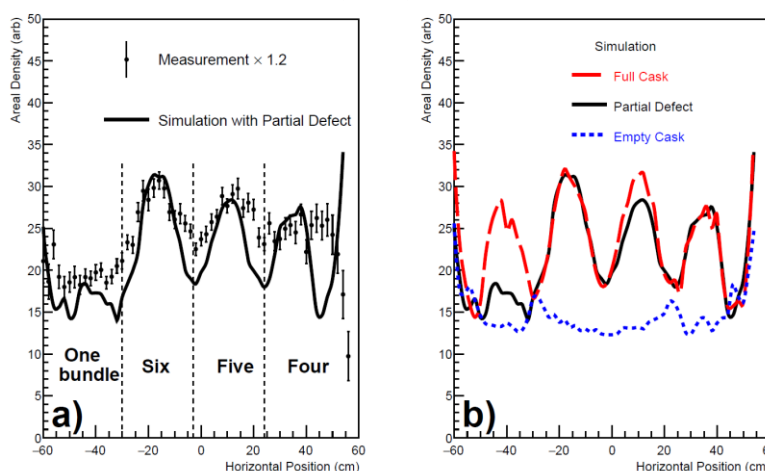
- Spent fuel safeguards
- Plutonium inventory verification
- Material control and accountability
- Passive imaging through shielding
- Non-destructive analysis

Current Capabilities

Measurements on a partially loaded dry storage cask at Idaho National Lab have shown the muon tomography is sensitive to the number of fuel bundles in the cask. Preliminary results are shown at right.



Muon tracking detectors around a partially-loaded MC-10 cask at Idaho National Lab.



Panel a) shows the measured areal density in between the two muon trackers. There is a clear difference between columns in the fuel basket holding different numbers of fuel bundles. These preliminary results are statistics limited but very encouraging. Panel b) shows the expected density in several different loading scenarios.

Anticipated Final Capabilities

We are planning follow up measurements from additional viewing angles around the cask to give complete tomographic information on the cask's contents. When completed, we will be able to provide:

- Complete tomographic image of the cask's contents.
- Design specifications for an instrument that is optimized for measurements of dry storage casks.
- Information on the benefits and limitations of cosmic ray muon tomography for dry cask storage verification

Project Description

Highly energetic cosmic ray muons are a natural source of ionizing radiation that can be used to make tomographic images of the interior of dense objects. Muons are capable of penetrating large amounts of shielding that defeats typical radiographic probes like neutrons or photons. This is the only technique which can examine spent nuclear fuel rods sealed inside dry casks.

Further Reading

*"Radiographic imaging with Cosmic Ray Muons" Nature **422**, 277 (2003).*

"Muon Radiography of the Toshiba Nuclear Critical Assembly Reactor" Appl. Phys. Lett. 104, 024110 (2014).

"Cosmic Ray Muon Imaging of Spent Nuclear Fuel in Dry Storage Casks" submitted for publication.